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GEOLOGIC INTERPRETATION
OF
AEROMAGNETIC MAP
ALLENTOWN QUADRANGLE

by

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FOREWORD

Southeastern Pennsylvania is an area of extremely varied and complex geology with a long history of mineral production. The list of mineral commodities which this area has yielded at various times is considerable, but iron-ore stands out as the most prominent. Scores of iron mines and furnaces have operated in this area in the past 200 years. With a record of production dating back to Pre-Revolutionary War years, the mine at Cornwall is America's oldest continuously operating iron mine in the United States. The recent development of the large and magnificent Grace Mine at Morgantown is living testimony to the fact that Pennsylvania's metallic mining record is not simply a story of the past. Through modern methods of exploration and research, new mineral resources remain to be found.

The Bureau of Topographic and Geologic Survey of the Department of Internal Affairs is pleased to have participated and cooperated with the U. S. Geological Survey in carrying out an aeromagnetic survey of Southeastern Pennsylvania. This modern exploration technique is particularly well suited to the geologic conditions and to the potential mineral resources of the area; it is an extremely efficient method of acquiring geologic data for a large region. The results of the aeromagnetic survey are being published by the U. S. Geological Survey as a series of aeromagnetic contour maps.

We are pleased to present this publication as a service to the Commonwealth of Pennsylvania. It is hoped that this interpretation and discussion of the aeromagnetic maps will serve as a stimulus for further research and development.

Genevieve Blatt

Genevieve Blatt, Secretary
Department of Internal Affairs

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General Statement

The magnetic contour maps being discussed in this series of publications are the result of a cooperative project of the United States Geological Survey and the Pennsylvania Geological Survey, Department of Internal Affairs. About 10,000 square miles of southeastern Pennsylvania have been covered in this survey, the results of which are being published as individual 7½-minute quadrangle maps.

This information circular is one of a series intended as a preliminary explanation of the interrelation of distinctive magnetic features with geological conditions in each quadrangle. In many instances unusual magnetic patterns can be explained by geological features which have been mapped and studied in the past. It is hoped that the map viewer will not only be aided by such correlation of data, but that this publication may stimulate exploration and research in those areas where there is at present no known or satisfactory geological explanation for some of the magnetic features which appear on the magnetic contour map. Such exploration and research could directly or indirectly lead to discovery and development of new mineral deposits and would greatly further the basic knowledge of the geology of Pennsylvania.

The magnetic contour lines on the map are lines connecting points of equal magnetic intensity. The shape, position, and spacing of the magnetic lines are due to the combined effects of the earth itself, which is a huge magnet, and to the local variations in the magnetism of the rocks underlying any given area. If only the earth as a large, uniform body were responsible for the magnetic lines, they would be essentially straight and simple. It is the local geology, however, which imparts complexities to the patterns of the magnetic lines. Such complexities or variations from a simple pattern are called anomalies.

Local magnetic effects vary from place to place because the magnetic properties of the respective rocks are not alike or because differences in rock structure from place to place change the magnetism measured at the surface. Rocks which have different kinds or different relative amounts of minerals, particularly iron-bearing minerals, have unlike magnetic properties. In general, the more iron minerals present, the stronger the magnetic effect. The iron oxide mineral, magnetite, has a strong magnetic effect even when present in small quantities; when present in large amounts, magnetite is of economic interest as a possible iron ore.

If in a given area the rocks have been folded or faulted by internal earth forces, the resulting variation in position of the different rocks will be indicated by variation in magnetic readings from place to place. Thus, structural complexities as well as mineral variations may be revealed by the magnetic data. Of particular interest are those magnetic variations or anomalies which are circular or tend to enclose a given area; the implication in such cases is that there is a specific, localized causative factor more or less pin-pointed by such a pattern.

The aeromagnetic survey of southeastern Pennsylvania was carried out with the use of an airborne magnetometer, an instrument towed by a plane. The plane covered the area by flying back and forth along straight, parallel flight lines spaced a quarter mile apart. An attempt was made to maintain an elevation of 500 feet, above the ground so as to eliminate magnetic changes due solely to terrain changes. An airborne magnetic survey has the advantage of eliminating very minor magnetic features on the ground, thus permitting a better evaluation of larger and deeper magnetic phenomena. It should be borne in mind that the instruments which have measured the magnetic effects in these studies are very sensitive and capable of detecting small changes. Proper evaluation of these changes is necessary to distinguish those situations which offer possibilities for economic mineral development from those cases where the information yielded is of more academic interest.

mines only worked the ore at shallow depths above the water table, a limitation which has been somewhat removed today by improved pumping techniques.

The airborne magnetic anomaly at Vera Cruz indicates that significant magnetite mineralization still exists there. However, it will require extensive exploration to ascertain the economic possibilities of that location. Tonnage and average ore grade would have to be established by extensive drilling. It will be necessary to resolve the feasibility of mining iron-rich zones which are steeply inclined, and which have very variable thickness, the maximum known to date being 15 feet. However, Edison's old idea of mining both the iron-rich zones and the intervening lean zones merits reconsideration in this area. There is often a tendency to pass over an area which has been mined and abandoned. The intensity of the Vera Cruz anomaly suggests this location merits careful re-examination.

The Allentown magnetic contour map shows a series of positive magnetic anomalies along South Mountain in Salisbury, Upper Saucon, and Lower Saucon townships. One such anomaly occurs about 1½ miles northeast of Emmaus and straddles the Salisbury-Upper Saucon Township line. This area of closure is oval-shaped, about 2 miles long and 1 mile wide and has an amplitude of about 400 gammas. Approximately 1 mile farther to the northeast along the same Salisbury-Upper Saucon Township line are four positive magnetic anomalies, each less than 1 mile in diameter and each with an amplitude on the order of 400 gammas. Another such anomaly occurs in Salisbury Township, about a mile northwest of Colesville. Farther north on South Mountain there is a small anomaly at Seidlersville, another about a mile northeast of Seidlersville, still another near Iron Hill, about 2 miles northeast of Seidlersville. Two other positive magnetic anomalies occur at the northern end of South Mountain, each being about 1 mile south of the Lehigh River; one is at Farmington and the other is at Fountain Hill. All of these relatively small anomalies on South Mountain occur at or near topographic highs and over gneissic rock which varies in composition in different places from granitic gneiss to hornblende-biotite gneiss. This is an extension of the same rock type which occurs at Vera Cruz with magnetite-rich zones. However, the size and amplitude of these South Mountain anomalies indicates that any magnetite concentration which may be responsible for each is quite limited in both area and degree of iron concentration. Unlike the Vera Cruz situation, these South Mountain anomalies appear to offer relatively little opportunity for possible economic development.

A more impressive positive magnetic anomaly occurs near Franklin School in Upper Saucon Township; about a mile southwest of Spring Valley. The anomaly area is over 1 mile long and nearly 1 mile wide; the amplitude of nearly 1000 gammas is one of the highest in the quadrangle. The spacing of the magnetic contours indicates a fairly shallow source of the anomaly. The high point of the anomaly lies in a valley at the foot of Saucon Hill, just west of Franklin School. This anomaly is somewhat irregular in shape and has three separate high points which indicates some complexity in the magnetic source. The area under the anomaly consists of a mass of gneiss which is flanked by sandstone and dolomite; the gneiss forms the core of an anticline. It is noteworthy that Saucon Hill, just to the north, exhibits no anomaly despite the fact that it is a pronounced topographic feature made up of similar crystalline gneiss. This indicates that it is not just simple contact between gneiss and sediment which is responsible for the Franklin School anomaly but rather that there must be a fairly concentrated magnetic source. Miller (1941) reports that prior to 1883 the Eichelberger and Frey mine produced some 4000 tons of magnetite ore at the foot of Saucon Hill, a few hundred feet north of this anomaly. That old mine was apparently producing from a magnetite-rich zone in the gneiss and it appears likely that the nearby anomaly under discussion is also the result of a magnetite concentration in the gneiss. It will require further exploration to determine the size and degree of iron mineralization present.

In the eastern third of the Allentown quadrangle, there is a group of positive magnetic anomalies, all lying over a complex area of gneiss. At Bitts Hill in Springfield Township, there is an anomaly less than a mile in diameter with an amplitude of about 600 gammas. This is the site of a small, abandoned magnetite prospect. On the Bucks-Northampton County line, about a mile north of Springtown, is a small anomaly half a mile in diameter and about 300 gammas amplitude. In Lower Saucon Township, about a mile west of Springtown, is an anomaly approximately half a mile in diameter with an amplitude of about 250 gammas. Near

Allentown Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 213

The northern half of the Allentown quadrangle magnetic contour map shows one large, relatively simple anomaly. The southern half of the quadrangle exhibits a large number of anomalies of various sizes, shapes, amplitudes, and orientations. This variation in magnetic pattern reflects the difference in geology between the two halves of the quadrangle. The northern half of the quadrangle is an area of sedimentary rocks with only a few broad folds and minor faults. The southern half of the Allentown quadrangle is manifested by igneous, metamorphic, and sedimentary rocks, all deformed by numerous folds and faults.

A large positive magnetic anomaly, about 9 miles long and 5 miles wide, is centered over Hanoverville and includes parts of Hanover, East Allen, Bethlehem and Lower Nazareth townships. This closed anomaly has an amplitude of 500 gammas; this indicates a significant high point in the magnetic attraction of the underlying rocks. However, the wide spacing of the magnetic contour lines within the anomaly indicates a depth of about 1 mile to the source of the anomaly. The anomaly appears to be due to either a broad protuberance of the buried crystalline rocks beneath the sediments or to a magnetic concentration within the buried crystallines. Just how much of an iron concentration may exist is impossible to determine from the magnetic picture, but the great depth which is indicated suggests that even if there were an unusually high concentration, mining would be economically and technically prohibitive.

The most pronounced positive magnetic anomaly in the Allentown quadrangle is located just north of Vera Cruz Station in Upper Milford Township. This oval-shaped anomaly trends northeasterly, has an amplitude of about 1800 gammas, and is about 1½ miles long and less than 1 mile wide. The anomaly occurs along the southern edge of an extrusive belt of Precambrian gneiss which ranges in composition from granite gneiss to hornblende gneiss. Within this gneiss are bands rich in magnetite. At one time the gneiss was considered to be entirely of igneous origin. Today it is believed by many that at least part of the gneiss is highly metamorphosed sedimentary rock and that some of the banding is indicative of the original sedimentary layers.

The Vera Cruz area has a history of mining of magnetite ore that dates back to pre-Civil War years. The last mining attempt was made during the First World War. At least eight mines have operated in this one area at various times and it is estimated that in total they produced over 300,000 tons of ore. Most of the mines were underground operations with shafts and extensive tunnels. A number of iron ore furnaces in the area were maintained by the local ore. Over one part of the Vera Cruz area Thomas A. Edison directed a detailed ground magnetic survey (Miller 1941) which helped to clarify the nature of the iron mineralization.

The aeromagnetic anomaly at Vera Cruz indicates the anomaly source is at a shallow depth of less than 500 feet, and occurs in a mass which has a steep side to the northwest and a gentle slope to the southeast. This fits the general picture which has evolved from the mines of the area as well as the Edison ground magnetic survey. The gneiss contains what have been variously called tabular bodies, beds, and veins which are rich in magnetite grains intermixed with quartz, plagioclase feldspar, and varying amounts of pyrite, hornblende, mica, and chlorite. Several such magnetite-rich veins are known in the Vera Cruz area; they dip (slope) to the south at about 45° and have been found to extend laterally for as much as 1½ miles. Though these veins are generally parallel to each other, some do unite and some pinch out. The magnetite-rich veins have a maximum thickness of 15 feet, no vein maintaining a constant thickness. A horizontal tunnel at the old Jobst Mine showed a distance of over 250 feet between successive veins. Miller (1941) gives analyses of samples taken during the days of active mining. These show the iron-rich veins to average 42% iron while the more barren gneiss between the magnetite zones averaged 18% iron. There is some question as to whether these old analyses dealt with recoverable iron or total iron – a total iron figure would be misleadingly high inasmuch as non-recoverable iron present in silicate minerals would be included. Recent sampling in the Vera Cruz area has indicated a maximum recoverable iron content in the magnetite-rich zones to be on the order of about 30%. The early analyses show an average of 35% silica content in the ore zones and make mention of the presence of some titanium; both of these are objectionable in excess quantities.

The old reports on the Vera Cruz area indicate that the

Swoveberg in Lower Saucon Township, there is an elongate anomaly, about 1 mile long, with an amplitude of 700 gammas. Miller (1941) reports an abandoned pit in two feet of high-grade magnetite just a couple of hundred feet west of the peak of this anomaly. About half a mile north of the town of Lower Saucon is an elongate anomaly, about 2 miles in length, with an amplitude of 700 gammas. Approximately a mile southwest of Redington, near the Lehigh River, is an anomaly nearly a mile in diameter with an amplitude of 400 gammas. Each of these anomalies in the eastern half of the Allentown quadrangle appears to be the result of a magnetite concentration within the banded gneiss; the linear anomalies are all elongate in the direction of the gneissic banding, that is, to the northeast. Each of the anomalies of this group is associated with a topographic high and the relatively limited amplitudes do not favor the possibilities for economic iron concentrations in this part of the quadrangle.

Two anomalies of non-geologic origin appear on the map; both of these are industrial anomalies. One is over the Bethlehem Steel Company plant at the southern edge of Bethlehem and the other is near the center of Allentown.

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